Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
2008		**00-00-2008 to 00-00-2008**

4. TITLE AND SUBTITLE
Energy Losses in Simulated Relativistic Michigan A6 Magnetron With Shaped Cathode

5a. CONTRACT NUMBER
5b. GRANT NUMBER
5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

5d. PROJECT NUMBER
5e. TASK NUMBER
5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Air Force Research Laboratory, Directed Energy Directorate,High Power Microwave Division,Kirtland AFB,NM,87117

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADM002087. Proceedings of the 2008 IEEE International Vacuum Electronic Conference (9th) (IVEC 2008) Held in Monterey, CA on April 22-24, 2008. U.S. Government or Federal Rights License

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**1**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

P2.31: Energy losses in simulated relativistic Michigan A6 magnetron with shaped cathode

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Recently there has been much research interest in improving magnetron performance by employing various priming techniques, such as shaped cathodes and nonuniform magnetic fields. These priming techniques have been successfully applied to reduce magnetron noise and also improve mode-locking and efficiency [1][2].

Inserting a shaped cathode into the simulated Michigan magnetron yields a maximum efficiency (the RF output power for a cycle divided by the current times voltage input for that cycle) of 33% as opposed to 15% for the standard cathode. 33% is a very good efficiency figure for a relativistic high power magnetron—however conventional magnetrons often achieve efficiencies greater than 85%.

The current effort is to characterize the various energy losses with the eventual goal of improving efficiency beyond 33%. We have found that for an RF cycle, 41% of the input energy is deposited by the electrons into the anode, 3% of the energy is deposited by electrons in the cathode, 23% is deposited by electrons downstream of the cathode, and 33% is emitted as RF, as is shown in Fig. 1. We will show in detail the spatial profile of the energy deposition by the electrons.

The hope is that with a detailed understanding of the energy losses, we can invent means of improving the efficiency without making key tradeoffs, such as going to higher magnetic fields, achieving higher peak efficiency at the expense of longer rise times (which would lead to reduced energy efficiency), increasing device size, reduced maximum power output, etc.

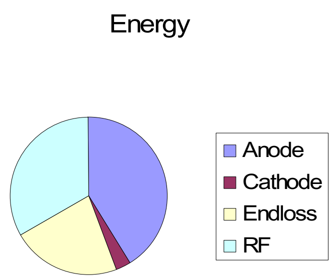

Fig. 1. Shown is the distribution of energy output for a single RF cycle of the A6 Michigan Magnetron. Most of the energy is lost as electron kinetic energy deposited in the anode, with lesser amounts deposited downstream and in the cathode. 33% of the energy input is converted to RF.

[1] "Magnetic priming effects on noise, startup, and mode competition in magnetrons", Neculaes et. al., *IEEE Transactions on Plasma Science*, Feb. 2005.
[2] "Virtual Prototyping of Novel Cathode Designs for the Relativistic Magnetron", Timothy P. Fleming et al., *Computing in Science & Engineering,* Nov/Dec 2007.